

Amendments to the Claims:

This listing of claims replaces all prior versions, and listings, of claims in this application.

Listing of Claims:

1-34. (Canceled)

35. (New) An NQR scanner for detecting the presence of a substance containing quadrupole nuclei in a scan volume comprising:

a pulse generator to generate pulse sequences with a frequency at or close to an NQR transition frequency;

a high power RF transmit amplifier for amplifying said pulse sequences;

a high Q, tuneable coil for producing a reasonably uniform magnetic field over the entire scan volume, said coil being part of a resonant circuit in which the resonant frequency can be varied;

an electromagnetic shield to enclose the coil allowing an opening to pass the object into the scan volume for detection, said electromagnetic shield being adapted to stop external interference from entering the scan volume and electromagnetic emissions from escaping from the coil and scan volume;

a tuning subsystem to determine if the introduction of the object into the coil has altered the resonant frequency of the resonant circuit, and to re-tune the resonant circuit close to the required resonant frequency;

a receiver system for amplifying a received signal from the coil after a delay from each transmitted pulse of the pulse sequence;

a processor to process the received signal to separate out the phase or amplitude or both phase and amplitude thereof;

a comparator for comparing the measured amplitude of the received signal with a prescribed threshold; and

a detector to detect whether the measured signal corresponds to an NQR signal emitted by the nuclei of the substance being tested and, if present, issue an alarm to alert an operator if the amplitude exceeds the prescribed threshold.

36. (New) An NQR scanner as claimed in claim 35, wherein the receiving system comprises:

- (i) amplification means to amplify the received signals;
- (ii) a mixer to mix the signals from a high frequency to a low frequency and produce quadrature signals for improving the SNR;
- (iii) an analogue-to-digital converter to digitise the signals after each transmitted pulse until the pulse sequence has finished for subsequent digital processing; and
- (iv) an accumulator to accumulate the digital signals received after each pulse until the pulse sequence has finished for subsequent digital signal processing.

37. (New) An NQR scanner as claimed in claim 36, wherein said amplification means comprises a small signal amplifier.

38. (New) An NQR scanner as claimed in claim 36, wherein said amplification means comprises a cold damped amplifier consisting of a matching system and amplifier for amplifying signals received from a low NQR frequency scan.

39. (New) An NQR scanner as claimed in claim 38, wherein said amplification means includes a high impedance amplifier for amplifying signals received from a high NQR frequency scan.

40. (New) An NQR scanner as claimed in claim 35, including a power matching unit to transfer optimum power from said transmit amplifier to said coil at substantially every frequency the NQR scanner operates.

41. (New) An NQR scanner as claimed in claim 35, including a low equivalent series resistance (ESR) switch to switch a large capacitance into and out of the tuneable circuit for changing between low and high resonant frequencies, whilst maintaining a low equivalent series resistance to maintain a high Q in the circuit at low resonant frequencies.

42. (New) An NQR scanner as claimed in claim 35, including an isolator to isolate the coil from the receiver system.

43. (New) An NQR scanner as claimed in claim 35, wherein said processor comprises a computer to process the accumulated signals by filtering, performing a Fast Fourier transform, and cross-correlation techniques to separate out the phase and amplitude of the accumulated signals.

44. (New) An NQR scanner as claimed in claim 35, wherein the coil is a multiple loop coil.

45. (New) An NQR scanner as claimed in claim 35, wherein the coil is a sheet single turn coil.

46. (New) An NQR scanner as claimed in claim 35, wherein the scanner includes an electric field shield circumscribing the inside of the coil within the scan volume to limit and contain the electric field produced by the coil so that it interferes to the smallest possible extent with the object being scanned.

47. (New) An NQR scanner as claimed in claim 35, including a temperature probe to measure the temperature, and said processor calculating the requisite adjustment to the frequency used within the pulse sequence in the light of the temperature having regard to the resonant frequency for the substance at that temperature and controlling the pulse generating means to generate the pulse sequence at the adjusted resonant frequency.

48. (New) An NQR scanner as claimed in claim 35, including a Q switch to reduce the Q factor of the coil circuit to a minimum directly after a pulse of the pulse sequence is transmitted, and then return the Q of the circuit to a high level for sensing and measuring the received signal.

49. (New) An NQR scanner as claimed in claim 35, including a conveyor belt controllable to automatically transport an object to be scanned to a position close to the centre of the scan volume, and to automatically stop the object at such position so that it can be scanned.

50. (New) An NQR scanner as claimed in claim 35, including a second outer shield to provide extra protection against external interference from entering the scan volume.

51. (New) An NQR scanner as claimed in claim 35, wherein said pulse generating means is controlled to generate pulse sequences that combat magnetoacoustic ringing and temperature induced intensity anomaly effects.

52. (New) An NQR scanner as claimed in claim 35, including RF curtains to prevent the escape of RF interference and prevent RF noise from entering the scan volume.

53. (New) An NQR scanner as claimed in claim 52, wherein said RF curtains comprise a rubber backed copper curtain.

54. (New) An NQR scanner as claimed in claim 35, including doors to prevent the escape of RF interference and prevent RF noise entering the scan volume.

55. (New) An NQR scanner as claimed in claim 35, including a tuning probe disposed part way between the coil and the shield for the purposes of tuning the coil to the requisite frequency for detection purposes prior to scanning an object brought into the scan volume of the coil.

56. (New) An NQR scanner as claimed in claim 35, including an optical fence system to sense the presence of an object approaching the scanner for scanning, to control the conveyance of the object to the scan volume for scanning and to control subsequent discharge of the object therefrom after scanning.

57. (New) An NQR scanner as claimed in claim 35, including a remote operating pod for informing an operator of the scanner the status of the system.

58. (New) A method for detecting the presence of a substance containing quadrupole nuclei within an object, comprising:

conveying an object into a scan volume;

determining whether the introduction of the object into the scan volume has altered the resonant frequency for detecting a prescribed substance having quadrupole nuclei within the object;

re-tuning a high Q, tuneable coil to the requisite resonant frequency with the object in the scan volume;

controlledly generating a pulse sequence to excite NQR in the substance if present in the object;

amplifying said pulse sequence to produce sufficient magnetic field strength from the tuneable coil to irradiate the scan volume for detection purposes and cause an NQR transition to a detectable level within the substance if present within the object;

irradiating the entire scan volume reasonably uniformly with a pulsed magnetic field at the requisite resonant frequency created by the application of the amplified pulse sequence to the tuneable coil;

shielding the tuneable coil and scan volume to stop external interference from entering the scan volume and electromagnetic emissions from escaping from the coil and scan volume;

amplifying a received signal from the coil after a delay from each transmitted pulse of the pulse sequence causing irradiation of the object and treating said received signal to improve the SNR;

processing the received signal to separate out the phase or amplitude, or both phase and amplitude thereof;

comparing the measured amplitude of the received signal with a prescribed threshold; and

detecting whether the measured signal corresponds to an NQR signal emitted by the nuclei of the substance being tested, and if present issuing an alarm to alert an operator if the amplitude exceeds the prescribed threshold.

59. (New) A method as claimed in claim 58, including power matching to ensure optimum power transfer from the amplified pulse sequence to the tuneable coil at the requisite resonant frequency.

60. (New) A method as claimed in claim 58, including switching the pulsed magnetic field between high and low resonant frequencies as appropriate for exciting NQR in a substance

within the object, maintaining a low equivalent series resistance with the tuneable coil during such switching.

61. (New) A method as claimed in claim 58, including isolating the tuneable coil from the amplification of the received signal.

62. (New) A method as claimed in claim 58, wherein said treating involves mixing the received signals with a reference and enhancing the mixed signals in quadrature.

63. (New) A method as claimed in claim 62, including digitizing and averaging the enhanced signals after each transmitted pulse until the pulse sequence has finished.

64. (New) A method as claimed in claim 63, including accumulating or digital processing the digitized and averaged signals over the pulse sequence.

65. (New) A method as claimed in claim 58, including separately matching and amplifying low and high frequency received signals.

66. (New) A method as claimed in claim 64, including processing the accumulated signals by filtering, performing the fast Fourier transform, and cross-correlation techniques to separate out the phase and amplitude of the accumulated signals.

67. (New) A method as claimed in claim 58, including electric field shielding the inside of the coil within the scan volume to limit and contain the electric field produced by the coil so that it interferes to the smallest possible extent with the object being scanned.

68. (New) A method as claimed in claim 58, including measuring the temperature and calculating the requisite adjustment to the resonant frequency of the pulse sequence in the light thereof having regard to the substance being detected, and controlling the generating of the pulse sequences to the adjusted resonant frequency.

69. (New) A method as claimed in claim 58, including reducing the Q factor of the coil to a minimum directly after a pulse of the pulse sequence is transmitted, and then returning the Q of the circuit to a high level for sensing and measuring the received signal.

70. (New) A method as claimed in claim 58, including automatically transporting the object to be scanned to a position close to the centre of the coil within the scan volume, and to automatically stop the object at such position so that it can be scanned.

71. (New) A method as claimed in claim 58, including further shielding to provide extra protection against external interference from entering the scan volume.

72. (New) A method as claimed in claim 58, including controlling the generating of the pulse sequences to combat magnetoacoustic ringing and temperature induced intensity anomaly effects.

73. (New) A method as claimed in claim 58, including preventing the escape of RF interference and preventing RF noise from entering the scan volume via the openings through which the object passes to and from the scan volume.

74. (New) An NQR scanner for detecting the presence of a substance containing quadrupole nuclei in a scan volume comprising:

means for generating pulse sequences with a frequency at or close to an NQR transition frequency;

means for high power amplifying said pulse sequences for RF transmission;

means for producing a reasonably uniform magnetic field over the entire scan volume;

means for tuning the uniform magnetic field with a high Q to a resonant frequency that can be varied;

means for electromagnetically shielding the magnetic field around the scan volume to stop external interference from entering the scan volume and electromagnetic emissions from escaping from the coil and scan volume, and having an opening to pass the object into the scan volume for detection;

means for determining if the introduction of the object into the coil has altered the resonant frequency to which the magnetic field has been tuned, and to re-tune the magnetic field close to the required resonant frequency;

means for amplifying a received signal from the scanned volume after a delay from each transmitted pulse of the pulse sequence;

means for processing the received signal to separate out the phase or amplitude or both phase and amplitude thereof;

means for comparing the amplitude of the received signal with a prescribed threshold; and

means for alerting an operator if the amplitude exceeds the prescribed threshold.